IN-PLACE DENSITY OF BITUMINOUS MIXES USING THE NUCLEAR MOISTURE-DENSITY GAUGE
FOP FOR WAQTC TM 8

Scope

This procedure covers the determination of density of bituminous mixes in accordance with WAQTC TM 8. Direct transmission and backscatter methods are covered. Correlation with densities determined under the FOP for AASHTO T 166 is required by some agencies.

All operators will be trained in radiation safety prior to operating nuclear density gauges. Some agencies require the use of personal monitoring devices such as a thermoluminescent dosimeter or film badge.

Apparatus

- Nuclear density gauge with the factory matched standard reference block.
- Drive pin, guide, scraper plate, and hammer for testing in direct transmission mode.
- Transport case for properly shipping and housing the gauge and tools.
- Instruction manual for the specific make and model of gauge.
- Radioactive materials information and calibration packet containing:
  - Daily Standard Count Log
  - Factory and Laboratory Calibration Data Sheet
  - Leak Test Certificate
  - Shippers Declaration for Dangerous Goods
  - Procedure Memo for Storing, Transporting and Handling Nuclear Testing Equipment
  - Other radioactive materials documentation as required by local regulatory requirements.

Material

- Filler material: Fine graded sand from the source used to produce the asphalt pavement or other agency approved materials.

Calibration and Standardization

1. Calibrate the nuclear gauge as required by the agency. This calibration may be performed by the agency using manufacturer’s recommended procedures or by other facilities approved by the agency.

2. Standardize the nuclear gauge at the construction site at the start of each day’s work and as often as deemed necessary by the operator or agency. Turn the gauge on and allow it to stabilize for 10 to 20 minutes prior to standardization. Record the standard count for

both density and moisture in the Daily Standard Count Log. The exact procedure for standard count is listed in the manufacturer's Operators Manual.

Note 1: Daily variations in standard count shall not exceed the daily variations established by the manufacturer of the gauge. If the daily variations are exceeded after repeating the standardization procedure, the gauge should be repaired and or recalibrated.

Procedure

1. Turn the gauge on and allow it to stabilize for 10 to 20 minutes prior to use, and leave the power on during the day's testing.

2. Standardize the gauge by performing standard counts as covered in Step 2 above under Calibration and Standardization.

   Note 2: New standard counts may be necessary more than once a day. See agency requirements.

3. Select a test location(s) in accordance with the project specifications. Test sites should be relatively smooth and flat. If the gauge will be closer than 600 mm (24 in.) to any vertical mass, or less than 300 mm (12 in.) from a vertical pavement edge, use the gauge manufacturer's correction procedure.

4. Maintain maximum contact between the base of the gauge and the surface of the material under test. Use filler material to fill surface voids. Spread a small amount of filler material over the test site surface and distribute it evenly. Strike off the surface with a straight edge guide or scraper plate, and remove excess material.

5. Mark the outline or footprint of the gauge with a crayon.

6. Direct transmission mode

   a. Use the guide and scraper plate as a template and drill a hole to a depth of at least 7 mm (0.3 in.) deeper than the measurement depth required for the gauge.

   b. Place the gauge on the test site and extend the probe to a depth not to exceed the thickness of the lift of pavement being measured. Pull the gauge so that the probe is firmly against the side of the hole.

   Note 3: If the depth of the pavement lift under test location is less than the depth of measurement of the gauge, the test count must be adjusted.

   c. Take a one-minute test and record. Rotate the gauge 90 degrees. Reseat the gauge by gently moving it side to side while pulling back. Take another one-minute test and record.

7. Backscatter mode

a. Place the gauge on the test site and extend the probe to the backscatter position.

b. Take a one-minute test and record. Rotate the gauge 90 degrees about the probe. Take another one-minute test and record.

   Note 4: If the difference between the two one minute tests is greater than 40 kg/m^3 (2.5 lb/ft^3), retest in both directions.

Calculation of Results

The density reported for each test site shall be the average of the two individual one-minute tests.

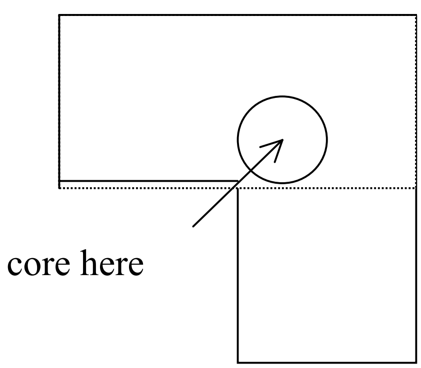
Percent compaction is determined by comparing the in-place wet density as determined by this method to the appropriate agency density standard. See appropriate agency policy for use of density standards.

Correlation with Cores

Note 5: When density correlation with test method AASHTO T 166 is required, correlation of the nuclear gauge with pavement cores shall be made on the first day's paving (within 24 hours) or from a test strip constructed prior to the start of paving. Cores must be taken before traffic is allowed on the pavement.

1. Determine the number of cores required for correlation from the agency's specifications. Cores shall be located on the first day's paving or on the test strip. Locate the test sites in accordance with the agency's specifications. Follow the "Procedure" section above to establish test sites and obtain densities using the nuclear gauge.

2. Obtain a pavement core from each of the test sites. The core should be taken from the center of the nuclear gauge footprint. If direct transmission was used, locate the core at least 25 mm (1 in.) away from the edge of the drive pin hole.



3. Determine the density of the cores by AASHTO T 166, Bulk Specific Gravity of Compacted Bituminous Mixtures Using Saturated Surface-Dry Specimens.

4. Calculate a correlation factor for the nuclear gauge reading as follows.

   a. Calculate the difference between the core density and nuclear gauge density at each test site to the nearest 1 kg/m^3 (0.1 lb/ft^3) Calculate the average difference and standard deviation of the differences for the entire data set to the nearest 1 kg/m^3 (0.1 lb/ft^3).

   b. If the standard deviation of the differences is equal to or less than 40 kg/m^3 (2.5 lb/ft^3), the correlation factor applied to the nuclear density gauge reading shall be the average difference calculated above in 4.a.

   c. If the standard deviation of the differences is greater than 40 kg/m^3 (2.5 lb/ft^3), the test site with the greatest variation from the average difference shall be eliminated from the data set and the data set properties and correlation factor recalculated following 4.a and 4.b.

   d. If the standard deviation of the modified data set still exceeds the maximum specified in 4.b, additional test sites will be eliminated from the data set and the data set properties and correlation factor recalculated following 4.a and 4.b. If the data set consists of less than five test sites, additional test sites shall be established.

Note 6: The exact method used in calculating the Nuclear Gauge Correlation Factor shall be defined by agency policy.

Note 7: The above correlation procedure must be repeated if there is a new job mix formula. Adjustments to the job mix formula beyond tolerances established in the contract documents will constitute a new job mix formula. A correlation factor established using this procedure is only valid for the particular gauge and in the mode and at the probe depth used in the correlation procedure. If another gauge is brought onto the project, it shall be correlated using the same procedure. Multiple gauges may be correlated from the same series of cores if done at the same time. The same correlation factor may be used on different contracts when using the same combination of job mix formula and gauge. It may also be used when using different surfacing or overlay materials.

Note 8: For the purpose of this procedure, a job mix formula is defined as the percent and grade of paving asphalt used with a specified gradation of aggregate from a designated aggregate source. A new job mix formula may be required whenever compaction of the wearing surface exceeds the agency's specified maximum density or minimum air voids.

Core Correlation Example:

Core results from T166:		Density results TM-8:		Difference:	
2338 kg/m^3	144.9 lb/ft^3	2295 kg/m^3	142.1 lb/ft^3	43 kg/m^3	2.8 lb/ft^3
2306 kg/m^3	142.8 lb/ft^3	2275 kg/m^3	140.9 lb/ft^3	31 kg/m^3	1.9 lb/ft^3
2314 kg/m^3	143.3 lb/ft^3	2274 kg/m^3	140.7 lb/ft^3	40 kg/m^3	2.4 lb/ft^3
2274 kg/m^3	140.7 lb/ft^3	2243 kg/m^3	138.9 lb/ft^3	31 kg/m^3	1.8 lb/ft^3
2343 kg/m^3	145.1 lb/ft^3	2319 kg/m^3	143.6 lb/ft^3	24 kg/m^3	1.5 lb/ft^3
2329 kg/m^3	144.2 lb/ft^3	2300 kg/m^3	142.4 lb/ft^3	29 kg/m^3	1.8 lb/ft^3
2322 kg/m^3	143.8 lb/ft^3	2282 kg/m^3	141.3 lb/ft^3	40 kg/m^3	2.5 lb/ft^3

Average Difference: 34 kg/m^3 2.1 lb/ft^3

Standard Deviation: 7.0 kg/m^3 0.47 lb/ft^3

Report

Results shall be reported on standard forms approved by the agency. Include the following information:

- Location of test and thickness of layer tested
- Mixture type
- Make, model and serial number of the nuclear moisture-density gauge
- Mode of measurement, depth, calculated wet density of each measurement and any adjustment data
- Standard density
- Percent compaction and/or percent air voids
- Name and signature of operator